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Mucuna pruriens leaves extraction, antifungal activity, Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC)

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Abstract

Mucuna pruriens (L.) DC., commonly known as Velvet Bean, is a medicinally important legume widely used in traditional systems of medicine for its therapeutic and antimicrobial potential. The present study was conducted to evaluate the antifungal activity of *M. pruriens* leaf extracts along with the determination of Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC) values. Leaf samples were collected, shade-dried, powdered, and extracted using the Soxhlet extraction method with solvents of increasing polarity petroleum ether, chloroform, acetone, ethanol, and methanol. The methanolic extract, found to be the most potent, was tested for antifungal activity against *A. niger* (MTCC-282) and *T. reesei* (MTCC-164) using the agar well diffusion method. The extract exhibited significant antifungal activity, with inhibition zones increasing proportionally to concentration (25, 50, and 100 mg/ml) compared to the standard antifungal drug Itraconazole. MIC and MFC were determined using broth dilution and sub-culturing techniques, respectively, revealing the minimum concentrations required for growth inhibition and fungicidal action. The results indicated that *M. pruriens* possesses strong antifungal potential, suggesting that its bioactive phytochemicals could serve as promising natural alternatives to synthetic antifungal agents. This study provides a scientific basis for the traditional use of *M. pruriens* and supports its further exploration in pharmaceutical and agricultural applications.

Keywords: *Mucuna pruriens*, Soxhlet extraction, antifungal activity, methanolic extract, Minimum Inhibitory Concentration (MIC), Minimum Fungicidal Concentration (MFC), phytochemicals, medicinal plants

1. Introduction

The extraction of bioactive compounds from medicinal plants has become an essential step in identifying and characterizing natural products with therapeutic and antimicrobial potential. Medicinal plants synthesize a wide range of secondary metabolites such as alkaloids, flavonoids, phenolics, tannins, terpenoids, and saponins, which play important roles in plant defense and human health (Simsek & Whitney, 2024) [7]. These compounds can be efficiently recovered through solvent extraction techniques that utilize the polarity of solvents to selectively dissolve different classes of phytochemicals (Tiwari *et al.*, 2011) [13].

Mucuna pruriens (L.) DC., commonly known as Velvet Bean, is a tropical leguminous plant belonging to the family Fabaceae, well known for its nutritional and pharmacological significance (Simmons, 2018) [9]. It has been used traditionally in Ayurvedic and folk medicine for the treatment of neurological disorders, infections, and metabolic diseases (Devhade *et al.*, 2015) [4]. The extraction and phytochemical analysis of *M. pruriens* have revealed the presence of numerous bioactive constituents that contribute to its therapeutic potential (Ahmad & Singh, 2014; Bhusare *et al.*, 2021) [1, 2, 22]. Plants are constantly exposed to abiotic and biotic stresses that trigger the accumulation of Reactive Oxygen Species (ROS) and secondary metabolites. These bioactive compounds, including flavonoids and phenolics, play crucial roles in stress tolerance and pathogen defense. Similar responses have been reported in *Gmelina arborea* under salinity stress, where increased antioxidant enzyme activity (catalase and peroxidase) contributed to oxidative stress mitigation (Ahmad, 2020) [3].

Recent studies have employed Soxhlet extraction using solvents of varying polarity-such as petroleum ether, chloroform, acetone, ethanol, and methanol to isolate bioactive metabolites from *M. pruriens* leaves and seeds (Narayanan *et al.*, 2021) ^[5]. Among these, methanol has been found to be the most effective solvent for recovering polar compounds including phenolics, flavonoids, and fatty acids (Shelke *et al.*, 2022) ^[6]. The extracts obtained were later characterized through Gas Chromatography-Mass Spectrometry (GC-MS), which identified several biologically active compounds such as catechol, 4-vinylphenol, p-cymene-2,5-diol, dimethyl phthalate, and n-hexadecanoic acid (Sruthi *et al.*, 2023) ^[10]. These findings suggest that optimized extraction procedures play a crucial role in enhancing the yield and biological activity of plant-derived compounds.

In recent years, several studies from the Gopalganj region of Bihar have reported the potent biological activity of invasive alien species such as *Ageratum conyzoides*, *Eupatorium adenophorum*, and *Mikania micrantha*, which exhibited significant cytotoxic, antioxidant, and anti-inflammatory properties (Siddiquee & Ahmad, 2022) ^[8]. These findings indicate that naturally occurring phytochemicals, including phenolics, flavonoids, and terpenoids, play a major role in the antimicrobial defense mechanisms of plants. Such evidence further supports the investigation of native and medicinally important species like *Mucuna pruriens* (L.) DC., which belongs to the Fabaceae family and has a rich history of traditional medicinal use, for its potential antifungal efficacy.

Besides its antimicrobial potential, *Mucuna pruriens* is also recognized for its high content of L-DOPA, a pharmacologically important amino acid precursor used in the treatment of Parkinson's disease (Srivastava *et al.*, 2024) ^[11]. The conventional propagation of *M. pruriens* is limited by poor seed viability and germination rate. Therefore, *in vitro* propagation techniques such as callus culture and somatic embryogenesis have been explored as alternative methods for large-scale plant production and conservation, while also enabling the quantification of L-DOPA content in regenerated plants. Bihar's floristic diversity has undergone notable transformation due to the introduction and establishment of several exotic and alien plant species, particularly from tropical regions. Studies conducted in the Gopalganj district have documented around twenty such dicotyledonous species belonging to families like Amaranthaceae, Tiliaceae, Euphorbiaceae, and Apocynaceae, many of which possess medicinal and economic importance (Siddiquee & Ahmad, 2021) ^[12]. This highlights the phytochemical richness and adaptability of tropical flora in this region, supporting the need to explore indigenous species such as *Mucuna pruriens* (L.) DC. for their antimicrobial and pharmacological potential.

In the present study, extraction of *Mucuna pruriens* leaf material was carried out using the Soxhlet extraction method to obtain crude solvent extracts for further evaluation of their antifungal activity, minimum inhibitory concentration (MIC), and Minimum Fungicidal Concentration (MFC). The extraction efficiency and the quality of phytochemical constituents directly influence the antifungal efficacy of the obtained extracts, emphasizing the importance of precise extraction techniques in pharmacological investigations.

2. Material and Methods

2.1 Collection of plant material

Fresh and healthy leaves of *Mucuna pruriens* (L.) DC. were collected from the local market of Lucknow, India. The collected samples were thoroughly washed with clean tap water followed by distilled water to remove surface impurities and dust particles. The cleaned leaves were shade-dried at room temperature to preserve heat-sensitive bioactive compounds. The dried samples were then pulverized into fine powder using an electric grinder, sieved through standard mesh filters, and stored in airtight containers at 4 °C for further extraction and antifungal assays.

2.2 Preparation of plant material

The dried leaves and pods of *Mucuna pruriens* were processed separately. Seeds were carefully removed from the pods, while immature, discolored, or diseased leaves were discarded. The selected leaves were finely chopped and ground using a sterile grinder. The powdered samples were stored in sterile airtight containers and preserved at 4 °C until extraction. Grinding the leaves to a fine consistency increased the surface area for solvent penetration and improved extraction efficiency (Tiwari *et al.*, 2011) ^[13].

2.3 Preparation of plant extracts

The extraction of phytochemical constituents from *Mucuna pruriens* leaves was carried out using the Soxhlet extraction method as described by Narayanan *et al.* (2021) ^[5] with minor modifications. About 15 g of powdered leaf material was packed into a cellulose thimble and extracted successively with petroleum ether, chloroform, acetone, ethanol, and methanol (150 ml each) for 24 hours using a Soxhlet apparatus. The temperature of extraction was maintained at the respective boiling point of each solvent to ensure maximum recovery of bioactive metabolites.

The obtained extracts were filtered through Whatman No. 1 filter paper and evaporated to dryness using a rotary evaporator. The concentrated extracts were then re-dissolved in a small volume (10 ml) of their respective solvents and stored in sterile, airtight vials at 4 °C for subsequent antifungal analysis. Among all extracts, the methanolic extract was primarily used for antifungal, MIC, and MFC studies owing to its higher extraction efficiency and phytochemical richness (Shelke *et al.*, 2022; Sruthi *et al.*, 2023) ^[6, 10].

2.4 Antifungal Activity Assay

The antifungal activity of the *Mucuna pruriens* leaf extracts was evaluated using the agar well diffusion method as described by Bauer *et al.* (1966) ^[14] with slight modifications. The assay was conducted against selected pathogenic fungi, namely *A. niger* (MTCC- 282), and *T. reesei* (MTCC- 164) which are known to cause significant human and plant infections. Pure fungal cultures were maintained on Potato Dextrose Agar (PDA) medium and incubated at 27 °C for 5-7 days to ensure active growth (Tiwari *et al.*, 2011) ^[13]. A fungal spore suspension (1×10^6 spores/ml) was prepared in sterile distilled water containing 0.1% Tween 80, and 0.1 ml of this suspension was uniformly spread over the surface of sterile PDA plates. Wells of 6 mm diameter were made using a sterile corn borer, and each well was loaded with 100 µL of different concentrations (25, 50, and 100 mg/ml) of the methanolic

extract of *M. pruriens*. Dimethyl sulfoxide (DMSO) served as the negative control, while Itraconazole (10 µg/ml) was used as the positive control for comparative evaluation. The inoculated plates were incubated at 27 °C for 72 hours, and the antifungal activity was determined by measuring the zone of inhibition (in mm) around each well using a Vernier caliper. All tests were carried out in triplicate, and the results were expressed as mean ± Standard Deviation (SD). The antifungal efficacy of the *M. pruriens* extracts was compared with that of the standard antifungal agent to determine their relative inhibitory potential (Shelke *et al.*, 2022; Sruthi *et al.*, 2023) [6, 10].

2.5 Minimum Inhibitory Concentration (MIC)

The Minimum Inhibitory Concentration (MIC) of the *Mucuna pruriens* leaf extracts was determined using the broth dilution method as described by Andrews (2001) and modified by Wiegand *et al.* (2008) [17]. The assay was performed to establish the lowest concentration of the plant extract capable of completely inhibiting visible fungal growth. Serial twofold dilutions of the methanolic extract were prepared in Potato Dextrose Broth (PDB) to obtain concentrations ranging from 1.25 to 100 mg/ml. Each dilution (1 ml) was inoculated with 0.1 ml of standardized fungal suspension (1×10^6 spores/ml) and incubated at 27 °C for 48-72 hours. A positive control containing Itraconazole (10 µg/ml) and a negative control containing only DMSO were maintained under identical conditions. After incubation, tubes were visually examined for turbidity to assess fungal growth. The MIC value was recorded as the lowest concentration of extract showing no visible growth compared to the control (Balouiri *et al.*, 2016) [16]. All assays were performed in triplicate to ensure reproducibility and accuracy of results.

2.6 Minimum Fungicidal Concentration (MFC)

The Minimum Fungicidal Concentration (MFC) of the *Mucuna pruriens* leaf extract was determined according to

the standard procedure described by Andrews (2001) [15] and Wiegand *et al.* (2008) [17], following the MIC assay. After determining the MIC, aliquots (0.1 ml) from each tube that showed no visible growth were aseptically sub-cultured onto fresh Potato Dextrose Agar (PDA) plates. The inoculated plates were incubated at 27 °C for 48-72 hours, and the fungal growth was carefully observed. The MFC was defined as the lowest concentration of the extract that completely inhibited fungal growth on the agar surface, indicating a fungicidal effect (Balouiri *et al.*, 2016) [16]. All tests were performed in triplicate to ensure reliability and reproducibility. The ratio of MFC to MIC was also used to distinguish between fungistatic and fungicidal activity, where an MFC/MIC ratio ≤ 4 indicated fungicidal potential of the extract (Cos *et al.*, 2006) [18].

3. Result and Discussion

3.1 Antifungal Activity

The methanolic extract of *Mucuna pruriens* showed concentration-dependent antifungal activity against *A. niger* and *T. reesei*, indicating the presence of potent bioactive compounds. The higher inhibition zones at increased concentrations suggest that phytochemicals such as flavonoids and phenolics may contribute to the antifungal effect. These findings highlight the potential of *M. pruriens* as a natural source of antifungal agents.

3.1.1 *Mucuna pruriens* extract against *A. niger*

The methanolic extract of *Mucuna pruriens* showed noticeable antifungal activity against *A. niger* (MTCC-282). As the extract concentration increased from 25 mg/ml to 100 mg/ml, the zone of inhibition also increased, suggesting that the antifungal activity of the extract is concentration-dependent. The comparative activity of the plant extract, standard antifungal drug (Itraconazole), and solvent control is summarized in Table 3.1.1.1.

Table 1: Antifungal activity of *M. pruriens* extract, Itraconazole (+ve control), DMSO (-ve control) against *A. niger* using well diffusion method

S. No.	Sample	Fungus	Concentration (mg/ml)	R ₁	R ₂	R ₃	Mean ± S.D.
1	<i>M. pruriens</i> extract	<i>A. niger</i>	C ₁ (100)	14.5	11.5	13	13.00 ± 1.50
2			C ₂ (50)	13	11	11.5	11.83 ± 1.04
3			C ₃ (25)	11	11	10	10.66 ± 0.57
4	Positive Control (Itraconazole)		300 ppm	13	13	12.5	12.83 ± 0.28
5	Negative Control (DMSO)		-	Nil	Nil	Nil	Nil

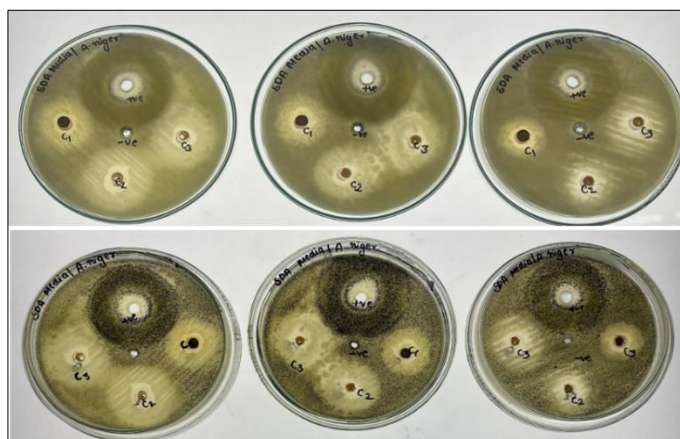


Fig 1: Antibacterial activity of *M. pruriens* extract of concentrations: 100mg/ml, 50mg/ml and 25mg/ml, against *A. niger* using Well Diffusion method; +ve control - Itraconazole used at 300ppm, -ve control DMSO

The antifungal potential of the *Mucuna pruriens* methanolic leaf extract was evaluated against *A. niger* using the agar well diffusion method. The extract exhibited measurable inhibitory zones, which increased proportionally with concentration, indicating a dose-dependent antifungal effect. The highest activity was observed at 100 mg/ml, producing a mean inhibition zone of 13.00 ± 1.50 mm, while lower concentrations (50 mg/ml and 25 mg/ml) produced inhibition zones of 11.83 ± 1.04 mm and 10.66 ± 0.57 mm, respectively. The standard antifungal agent, Itraconazole (300 ppm), produced a comparable inhibition zone of 12.83 ± 0.28 mm, whereas no inhibitory effect was observed in the negative control (DMSO). These findings confirm that the

antifungal activity is attributed to the bioactive constituents of the *M. pruriens* extract rather than the solvent.

3.1.2 *Mucuna pruriens* extract against *T. reesei*

The methanolic extract of *Mucuna pruriens* showed noticeable antifungal activity against *T. reesei* (MTCC-164). As the extract concentration increased from 25 mg/ml to 100 mg/ml, the zone of inhibition also increased, suggesting that the antifungal activity of the extract is concentration-dependent. The comparative activity of the plant extract, standard antifungal drug (Itraconazole), and solvent control is summarized in Table 3.1.2.

Table 2: Antifungal activity of *M. pruriens* extract, Itraconazole (+ve control), DMSO (-ve control) against *T. reesei* using Well Diffusion method

S.No.	Sample	Bacteria	Conc. (mg/ml)	Zone of Inhibition (mm)			
				R1	R2	R3	Mean±S.D.
1	<i>M. pruriens</i> extract	<i>T. reesei</i>	C1(15)	7.5	7.2	7	7.23±0.25
			C2 (10)	7	6.5	7	6.83±0.28
			C3 (5)	7	7	6.5	6.83±0.28
2	Pos Control (Itraconazole)		300ppm	23	16	18	19.00±3.60
3	Neg. Control (DMSO)		-	Nil	Nil	Nil	Nil

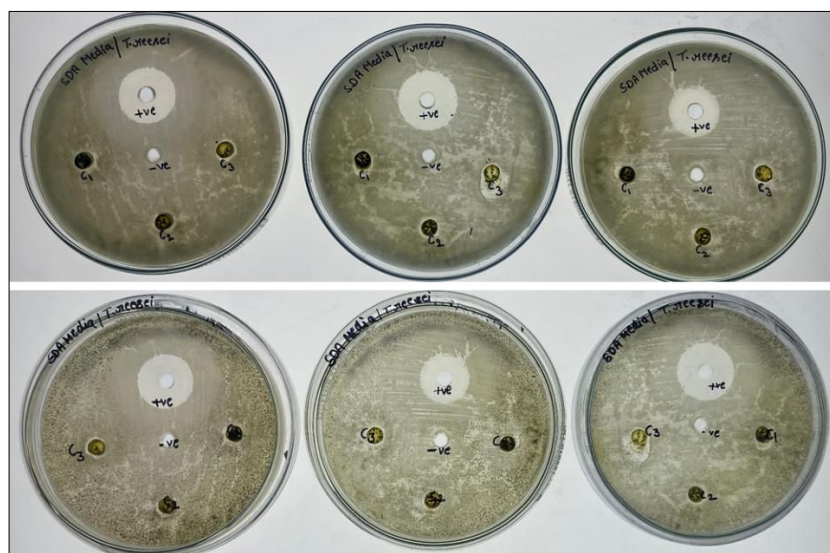


Fig 2: Antibacterial activity of *M. pruriens* extract of concentrations: 100mg/ml, 50mg/ml and 25mg/ml, against *T. reesei* using Well Diffusion method; +ve control - Itraconazole used at 300ppm, -ve control DMSO

The antifungal efficacy of the methanolic extract of *Mucuna pruriens* leaves was assessed against two fungal pathogens, *A. niger* and *T. reesei*, using the agar well diffusion method. The extract exhibited measurable inhibition zones that increased with concentration, indicating a dose-dependent antifungal effect. Against *A. niger*, the mean inhibition zones were 13.00 ± 1.50 mm, 11.83 ± 1.04 mm, and 10.66 ± 0.57 mm at concentrations of 100, 50, and 25 mg/ml, respectively. For *T. reesei*, the extract showed relatively lower activity, with inhibition zones of 7.23 ± 0.25 mm, 6.83 ± 0.28 mm, and 6.83 ± 0.28 mm at 15, 10, and 5 mg/ml concentrations, respectively. The standard antifungal drug, Itraconazole (300 ppm), produced inhibition zones of 12.83 ± 0.28 mm for *A. niger* and 19.00 ± 3.60 mm for *T. reesei*,

whereas the negative control (DMSO) exhibited no inhibitory effect.

3.2 Minimum Inhibitory Concentration (MIC)

The Minimum Inhibitory Concentration (MIC) assay was conducted to determine the lowest concentration of *Mucuna pruriens* methanolic extract capable of inhibiting visible fungal growth. The antifungal potential of the extract was tested against two pathogenic fungi, *A. niger* and *T. reesei*, using the broth dilution method. Fungal growth was quantified spectrophotometrically by measuring the absorbance (OD), and visually assessed based on turbidity levels categorized as NT (No Turbidity), WT (Weak Turbidity), and HT (High Turbidity). The results of MIC determination are presented in the Table 3.2.1.

Table 3: Minimum Inhibitory Concentration (MIC) of methanolic extract of *Mucuna pruriens* leaves against *A. niger* and *T. reesei*

Sample	Organism	Tube label	Concentration (%)	Absorbance/OD	Turbidity
<i>M. pruriens</i> extract	<i>A. niger</i>	C1	25	0.089	NT
		C2	12.5	0.257	WT

		C3	6.25	0.244	WT
		C4	3.125	0.273	WT
		C5	1.562	0.413	WT
		C6	0.781	1.285	HT
		C7	0.39	1.177	HT
	<i>T. reesei</i>	C1	25	0.275	WT
		C2	12.5	0.472	WT
		C3	6.25	0.816	WT
		C4	3.125	1.129	HT
		C5	1.562	1.396	HT

The methanolic extract of *Mucuna pruriens* exhibited notable antifungal activity against *A. niger*, showing complete inhibition of growth (no turbidity) at a concentration of 25%, which was recorded as the MIC value. At lower concentrations, weak to moderate turbidity was observed, indicating partial inhibition of fungal growth. In contrast, the extract showed limited inhibitory potential against *T. reesei*. Even at the highest concentration tested (25%), weak turbidity persisted, indicating incomplete growth inhibition. Therefore, the MIC value for *T. reesei* was considered greater than 25%, suggesting that this strain is more resistant to *M. pruriens* extract compared to *A. niger*.

Table 4: Determination of Minimum Fungicidal Concentration (MFC) of *M. pruriens* methanolic extract against *A. niger* and *T. reesei* based on visible fungal growth observations at different concentrations

Sample	Organism	Tested concentration (%)	Observation	Growth
<i>M. pruriens</i>	<i>A. niger</i>	25	No visible colonies	No Growth Observed
		12.5	Visible colonies	Growth Observed
	<i>T. reesei</i>	25	Visible colonies	Growth Observed
		12.5	Visible colonies	Growth Observed

The results indicate that *Mucuna pruriens* methanolic extract completely inhibited *A. niger* growth at 25% concentration, whereas partial growth was observed at 12.5%, establishing 25% as the effective fungicidal concentration for this fungus. In contrast, *T. reesei* showed visible growth even at 25%, indicating that this fungus is less susceptible to the extract under the tested conditions. These findings suggest that the antifungal efficacy of *M. pruriens* is both concentration and species dependent, with higher concentrations required to inhibit more resistant fungi like *T. reesei*.

3.4 Discussion

The methanolic leaf extract of *Mucuna pruriens* demonstrated considerable antifungal activity, particularly against *A. niger*, while the activity against *T. reesei* was comparatively weaker. The observed concentration dependent increase in inhibition zones implicates that bioactive phytochemicals within the extract exert their effect more strongly at higher dosages. This trend is consistent with previous reports of plant extracts showing dose dependent antimicrobial effects (Vaou *et al.*, 2021) [23]. The efficiency of extraction solvents directly influences the recovery of phytoconstituents, as also reported for cannabinoids where methanol-chloroform mixtures enhanced extraction yield and analyte recovery. Similar solvent polarity effects could explain the high yield of *M. pruriens* extract obtained in the present study (Mandrioli *et al.*, 2019) [24].

In our study, *A. niger* was completely inhibited (no visible turbidity) at 25% concentration, establishing the MIC at this level, and subculturing further confirmed it as the MFC (i.e.,

3.3 Minimum Fungicidal Concentration (MFC)

The Minimum Fungicidal Concentration (MFC) of the methanolic extract of *M. pruriens* was evaluated against *A. niger* and *T. reesei* using the broth dilution method. Different concentrations of the extract were tested to determine the lowest concentration capable of completely inhibiting fungal growth. The observations of visible or no growth at each concentration are presented in Table 3.3.1.

Table 3.3.1 Determination of Minimum Fungicidal Concentration (MFC) of *M. pruriens* methanolic extract against *A. niger* and *T. reesei* based on visible fungal growth observations at different concentrations.

fungicidal action at the same concentration). In contrast, *T. reesei* maintained weak turbidity even at 25%, denoting partial inhibition only, and in subcultures, growth reappeared, indicating fungistatic or weak effect rather than fungicidal. These interspecific differences suggest that *T. reesei* either has stronger innate resistance mechanisms (e.g., robust cell wall, efflux pumps, enzymatic detoxification) or the bioactive compounds in *M. pruriens* do not penetrate or act effectively in that fungus.

The bioactive components identified in *Mucuna pruriens* leaf extracts might act through mechanisms similar to those reported in *Cannabis sativa* and *Salvia divinorum*, where compounds such as terpenoids, phenolics, and saponins exhibit potent antimicrobial and anti-inflammatory effects (Priyanka & Ahmad 2023) [19]. Phytochemicals such as phenolics, flavonoids, terpenoids, alkaloids, and saponins are known to disrupt fungal cell walls, alter membrane permeability, inhibit enzymes, or generate oxidative stress (Khameneh *et al.*, 2019) [20]. The superior activity of the methanolic extract is plausible because methanol efficiently extracts polar constituents (e.g. phenolics, flavonoids) that are often more bioactive (Theansungnoen *et al.*, 2022) [21]. Additionally, *Mucuna pruriens* has been previously reported to show broad antimicrobial potential in other studies, supporting the legitimacy of our antifungal results (Salau *et al.*, 2007) [25].

The antifungal effect of *Mucuna pruriens* observed in this study could be linked to the presence of similar bioactive compounds reported in *Achyranthes aspera* extracts, where antioxidant and antibacterial activities were attributed to phenolics and flavonoids. The FTIR spectra of *Achyranthes aspera* showed the presence of hydroxyl, carboxylic, and

alkene functional groups that are also known to contribute to antimicrobial and antioxidant behavior, suggesting a comparable biochemical mechanism (Singh *et al.*, 2020) ^[26]. The antifungal activity observed in the present study is consistent with the traditional medicinal use of *Mucuna pruriens* and other ethnomedicinal plants documented in the Gopalganj region, where local healers (Vaidyas) employ *M. pruriens* seeds to treat conditions such as gonorrhea, menstrual disorders, and nervous diseases. Such ethnopharmacological evidence supports the pharmacological potential of *M. pruriens* extracts as reported in previous studies (Ahmad & Singh, 2014) ^[1].

While the extract showed promising fungicidal action against *A. niger*, its limited effect on *T. reesei* suggests that further fractionation and purification may be needed to isolate more potent compounds or synergistic mixtures. Also, optimization of extraction (solvent system, time, temperature) could enhance yield and antifungal efficacy (Vaou *et al.*, 2021) ^[23]. Future work might employ GC-MS or LC-MS to identify active constituents, and time-kill kinetics or microscopy to understand mode of action. Moreover, combining *M. pruriens* extracts with known antifungals might yield synergistic effects that reduce effective doses. The antifungal efficacy of *Mucuna pruriens* may be attributed to the presence of phenolic and ester-based compounds, which are also commonly detected in other Fabaceae members. For instance, GC-MS profiling of *A. lebbeck*, *C. fistula*, and *D. regia* identified bioactive molecules such as diisooctyl adipate and terephthalic acid derivatives known for their antimicrobial potential (Kumar *et al.*, 2023) ^[27]. Such phytoconstituents may contribute to the inhibitory activity observed against *A. niger* and *T. reesei* in the current study.

In summary, the study supports *Mucuna pruriens* as a potential natural antifungal source, with pronounced efficacy against *A. niger* under the tested conditions. The variable response across fungal species underscores the importance of species-level evaluation and the need for further mechanistic and phytochemical investigations.

4. Conclusion

The present study concludes that the methanolic leaf extract of *Mucuna pruriens* exhibits significant antifungal potential, particularly against *A. niger*, while showing comparatively weaker inhibition against *T. reesei*. The complete growth inhibition of *A. niger* at 25% concentration (MIC = 25%) and the absence of fungal regrowth at the same concentration (MFC = 25%) confirm its fungicidal nature. In contrast, *T. reesei* demonstrated partial inhibition even at the highest concentration tested, indicating higher resistance.

The study supports that medicinal climbers like *Mucuna pruriens* and *Quisqualis indica* L. contain diverse bioactive metabolites, confirming the therapeutic potential of phytochemicals in combating oxidative and inflammatory stress (Baitha *et al.*, 2024) ^[28].

The antifungal efficacy of *M. pruriens* is likely attributed to the synergistic action of its phytochemicals such as flavonoids, phenolics, alkaloids, and terpenoids which disrupt fungal cell wall integrity and inhibit essential metabolic enzymes (Khameneh *et al.*, 2019; Theansungnoen *et al.*, 2022) ^[20, 21]. These findings align with previous reports highlighting the broad-spectrum antimicrobial properties of *M. pruriens* and its potential as a natural

source of bioactive compounds (Salau *et al.*, 2007; Vaou *et al.*, 2021) ^[23, 25].

Therefore, *Mucuna pruriens* may serve as a promising candidate for developing eco-friendly antifungal formulations. However, further studies involving compound isolation, GC-MS profiling, and mode-of-action analysis are required to identify the key bioactive constituents responsible for its antifungal activity and to validate its practical applicability in pharmaceutical and agricultural fields.

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